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## Developing PHYCOM (Physics Comics) on Newton's Law Material for 10<sup>th</sup> Grade High School Students

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### Abstract

This research aims to develop high school physics teaching materials in the form of comics. This research method is a research and development (R&D) method. The steps in this method are Analysis-Design-Development-Implementation-Evaluation (ADDIE). A validation test was carried out using a questionnaire to obtain valid Physics Comics (PHYCOM) teaching materials. This feasibility test was carried out by three validators consisting of 1 high school physics teacher, two lecturers, and six 10<sup>th</sup>-grade high school students. Comics are said to be valid and feasible to use because they meet the validity percentage at a value of 61% - 100% (valid criteria and very valid). Based on the results of the feasibility test of the three validators, it was found that PHYCOM's teaching materials were very valid and feasible to use, with a percentage of 87.50%. The validation results from six students showed that PHYCOM was a very valid teaching material with a validity percentage of 91.18%. The results of this validation indicate that PHYCOM is valid and suitable to be used as teaching materials for 10<sup>th</sup> high school students. The advantage of PHYCOM teaching materials is that they are communicative and contain illustrative images so that they are easy to visualize. In addition, PHYCOM teaching materials can be used by students as independent study materials.

**Keywords:** physics, Newton's law, PHYCOM

### INTRODUCTION

Educating and learning assets are those human and material inputs essential for accomplishing the destinations of concepts to be instructed. It is the entirety of everything explicitly utilized or by implication for instructive preparation to encourage or empower the procurement of information competence, expertise, and know-how. In implementing education in schools, the learning carried out is influenced by several components: teachers, learning, curriculum, infrastructure, budget, and school management (Cholik et al. 2021).

Specifically, one component that has an essential role in implementing physics learning in schools is teaching materials. Physics teaching materials are constructive for teachers and students in effectively carrying out the physics learning process. The use of teaching materials can help students understand the lessons given by the teacher more deeply and are also efficient in using time. According to Nuryasana et al. (2020), with teaching materials, teachers will be more coherent in teaching materials to students and achieve pre-determined competencies. Furthermore, it is said that the use of teaching materials also determines the success of teachers in teaching.

In addition to helping students understand lessons and save time, there are many advantages and benefits of applying teaching materials in a learning activity. The advantages obtained by the application of teaching materials in learning, according to Tampubolon et al. (2015), namely: (1) Increase student motivation; (2) After the evaluation, the teacher and students know what is correct; (3) Students get results according to their abilities. Education is more effective because (4) learning materials are distributed more evenly throughout the semester, and (5) training materials are arranged based on levels.

Furthermore, it is found that the advantages and benefits that have been mentioned have a positive impact on learning. The positive impact of the role of teaching materials on students is that they reduce dependence on teachers and allow them to become accustomed to independent learning. Teaching materials help teachers and students to participate in learning activities, so teachers do not present too much material. In addition, some materials can replace the role of teachers and support individual learning (Lestari et al. 2016; Agustian et al. 2013).

Many types of teaching materials can be used in learning physics, such as handouts, textbooks, modules, student activity sheets, photos/pictures, and others (Girwidz and Kohnle 2021). Of the many types of teaching materials available, one of the teaching materials that can be used in physics learning is comic-based teaching materials. Comics are used to express ideas in images, often combined with text and other visual information. Comics are usually a series of parts that are juxtaposed. Comics can be interpreted as a form of comedy that depicts characters and narratives, literacy practices (Dallacqua et al. 2022), and even a moral message (Muliyati et al. 2021). Cartoons are one of the most popular reading materials among children and adolescents.

Comics are one of the prevalent instructive media compared to other media that are great for expanding students' information. The comedian is known as a learning media that presents pictures and incorporates a storyline so that the fabric can be effortlessly recollected (Haroky et al. 2019; Fitri et al. 2020). In development, comics are very easy and can even be assisted using an application (Sarinah et al. 2016). Comics can be used as a learning medium that is fun and interesting for students at all levels of school as well as being linked in learning exercises for students, and this media can be linked anywhere and anytime (Fuccia et al. 2012; Kim et al. 2017; Sari et al. 2019).

In addition to making it easier for someone to understand the plot and content of the story, comics can attract attention, teach, and support positive attitudes towards someone poor, increase the competence of interpretation of social information and inspire students, and improve students' storytelling skills (Tekle-Haimanot et al. 2016; Furuhashi-Turner 2013; Lestari & Mustadi 2020). Comics for material science learning are elective media that can be used to overcome issues in understanding a fabric. Using analogies and depictions of stories in everyday life can assist understudies in getting the better fabric. The comic showed that students understood more than when presented with a 'traditional' lesson (Baldacchino 2010).

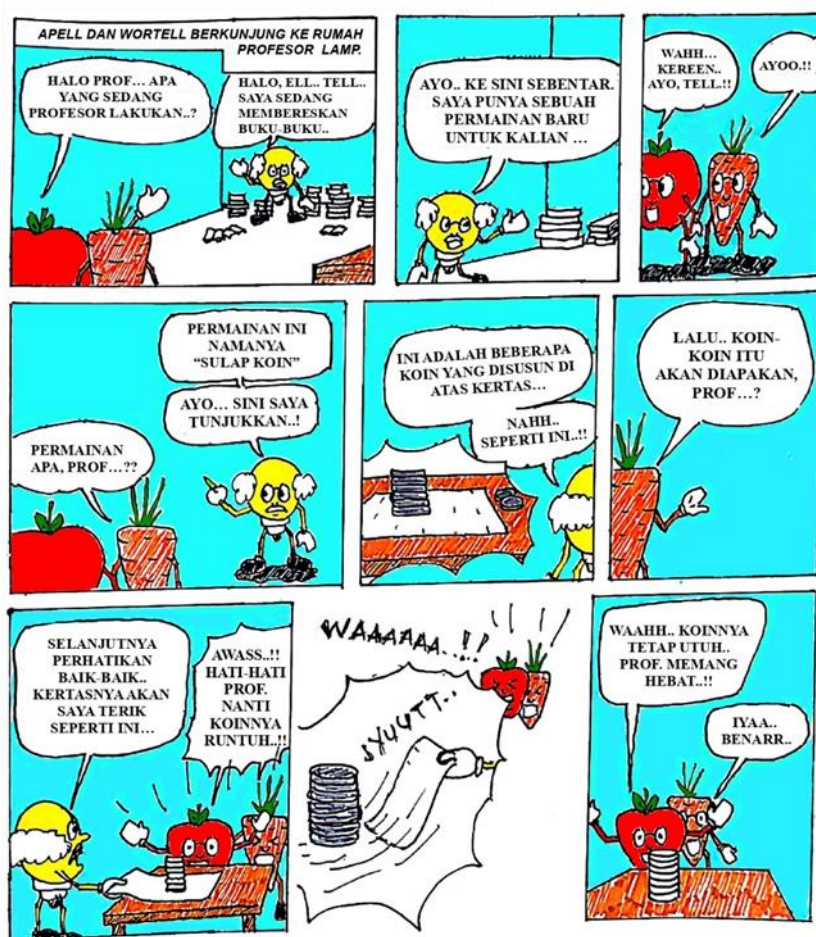


FIGURE 1. Examples of PHYCOM instruments

Self-study is an action taken by students to learn for themselves and have their ideas according to their needs. Self-study is the attitude of student initiative with full awareness of meeting their learning needs. According to Kirkman (2007) and Sari (2019), self-study is what process students need to learn, find answers, and formulate them. This is different from just reading. Besides that, self-study is an active learning activity that is driven by the intention or motivation to master a specific competency. Self-study is built based on existing knowledge or competencies. A student is said to have the ability to learn independently if he has the following characteristics, namely: being able to think critically, creatively, and innovatively, not being easily influenced by other people's opinions, not feeling inferior, continuing to work diligently and discipline, having the ability to work confidently, and to be responsible (Lestari 2015). The self-study provides understudies the opportunity to: (1) Decide the learning themselves; (2) arrange the learning process; (3) utilize the learning assets they select; (4) make scholarly choices; and (5) do the exercises they select to realize their learning destinations (Suwardika & Sawitri 2019).

In the education system, self-study is needed to achieve learning goals that encourage students to improve their skills actively. This allows students to adapt to the different learning styles they need to succeed according to their goals. To achieve learning objectives following curriculum objectives, students must find a way of learning that suits them. This can be achieved through self-exploration based on self-study.

Previous research results in Indonesia found that comic-based physics teaching materials were feasible and effective for teaching materials in class. The results obtained, for example, Anesia et al. (2018) found that learning media based on Android-based Physics comics was good and suitable for use in the physics learning process with a percentage of 80.39%. The results of other studies were found by Agustin et al. (2018) that the Physics comic module is valid and effective in learning Physics

in the classroom, with a validity level of 78.75% and an effective level of 71.38%. Meanwhile, Lesmono et al. (2012) found that learning Physics using comic-based Physics teaching materials can increase student motivation and understanding, where the data on the percentage of student learning motivation is classically 89.93%. Meanwhile, students understanding of concepts in classical was 92.08%. Lesmono et al. (2012) also found that students had no difficulty using physics teaching materials in the form of comics during class learning.

Based on some of the previous research, it was obtained suggestions that became a reference in the implementation of further research, namely that comic-based physics learning media should be designed and developed on different physics materials. In addition, the use of physics teaching materials in the form of comics should be done on a computer basis to increase student motivation further.

Therefore, this research is the development of comic-based physics teaching materials on Newton's Law of motion, including Newton's First Law, Newton's Second Law, and Newton's Third Law. The development of this Physics comic teaching material aims to improve students' self-study abilities.

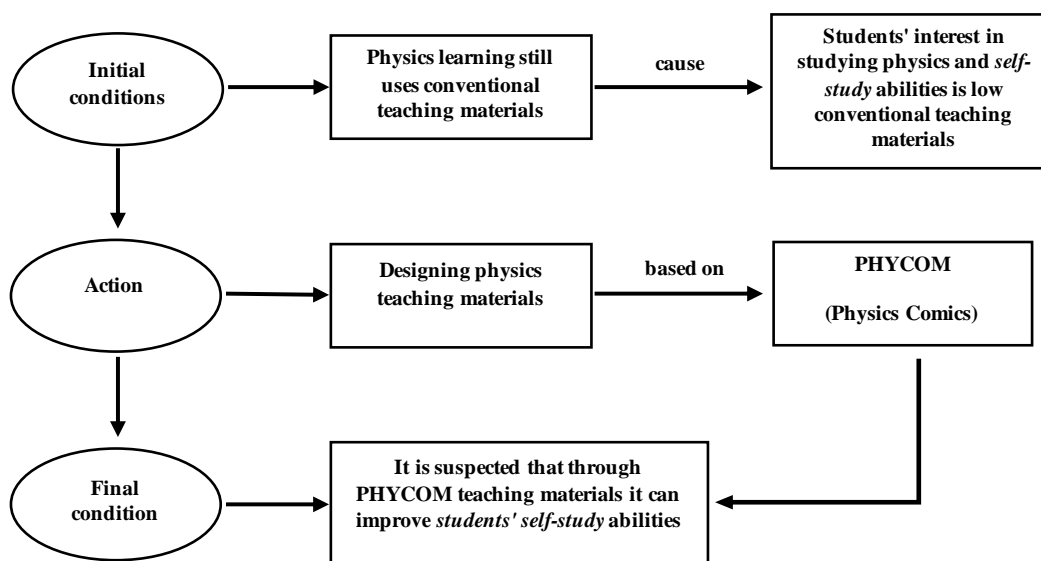


FIGURE 2. Research frame work

## METHODS

### Research Schedule and Participants

This research was conducted in June 2021. The research subjects used in this study amounted to 9 people, three expert validators, and six high school students in grade 10 in the science program. The expert validators used consisted of 2 lecturers and 1 Physics teacher.

### Instrument

The instruments used in this study are 1) comic-based physics teaching materials (PHYCOM), and 2) Questionnaire validation of teaching materials. The data analysis process in this study includes the analysis of the validation questionnaire of teaching materials by expert validators and students.

TABLE 1a. PHYCOM validation questionnaire instrument

No	Aspect	Statement
1	Writing display	Writing the title on the comic is correct The size of the letters in the comic text is appropriate The use of words in comic dialogue meets the criteria The writing in the comic media is clear The use of language makes it easier to understand the storyline

No	Aspect	Statement
2	Image display	The shape of the image is appropriate Image size is appropriate The suitability of the image with the text is correct The images on the comics vary The color composition is right
3	Function of PHYCOM	Comics are suitable as a learning resource The language of delivery used for comics is easy to understand (not verbalistic) Comics teaching materials are able to attract reading interest
4	Benefits of PHYCOM	Presentation of comic illustrations leads to understanding the concept The proportion of comics as entertainment and knowledge enhancing tools Comic media creates a sense of pleasure when reading it and encourages readers to read it completely

### Research Model

This study uses a research and development (R&D) design with the ADDIE (Analysis-Design-Development-Implementation-Evaluation) model developed by Dick & Carry in 1996 to design a learning system (Cahyadi 2019).

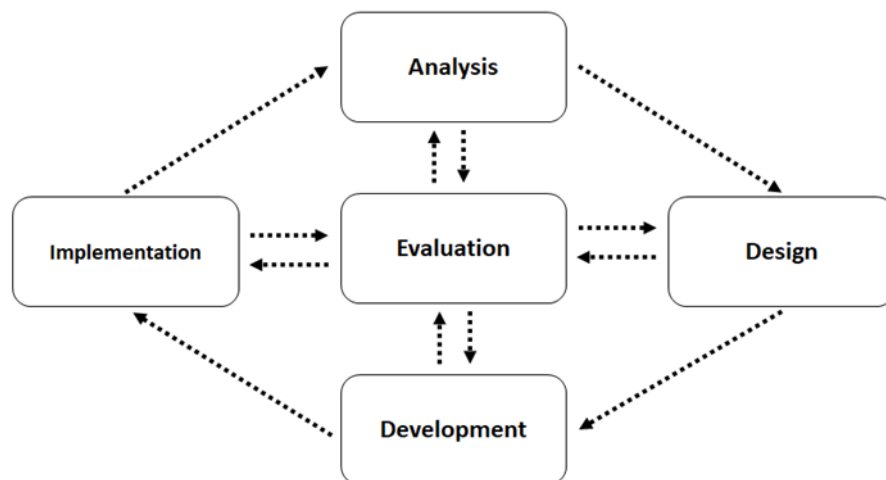


FIGURE 3. R&D research steps using the ADDIE method

In this teaching material development research, three steps of the research and development (R&D) method are used: Analysis, Design, and Development (ADD).

#### Analysis

At the analysis stage, activities are carried out related to problems in high school physics learning and environmental conditions based on the applicable curriculum. The things that are done at the analysis stage are:

a. Needs analysis

Analysis of the needs of 10<sup>th</sup>-grade high school students to find out the fundamental problems in learning Physics. At this point, it is analyzed that it is necessary to develop teaching materials that are more communicative, varied and attract students' learning interest. Data related to the analysis



- of student needs were obtained by reviewing theories, conducting interviews with physics teachers, and observing during learning activities.
- b. Analysis of student characteristics  
 Analysis of student characteristics aims to determine the characteristics of students who are the object of research. This analysis includes the level of ability, background knowledge, cognitive development, and students' views of physics.
  - c. Curriculum analysis  
 Curriculum analysis includes analysis of Core Competencies and Basic Competencies in accordance with the applicable curriculum in schools, namely the 2013 Curriculum. So that the analysis at this point is to know the minimum competencies that students must achieve in accordance with the learning objectives, namely in Newton's Law of motion material.

*Design*

At the design stage, a product design is carried out in the form of comic teaching materials about Newton's Law. This comic-based teaching material is designed manually. The manual method in question is drawing comics by hand and using manual writing tools. The material used is Newton's Law of motion which includes Newton's 1<sup>st</sup> Law, Newton's 2<sup>nd</sup> Law, and Newton's 3<sup>rd</sup> Law.

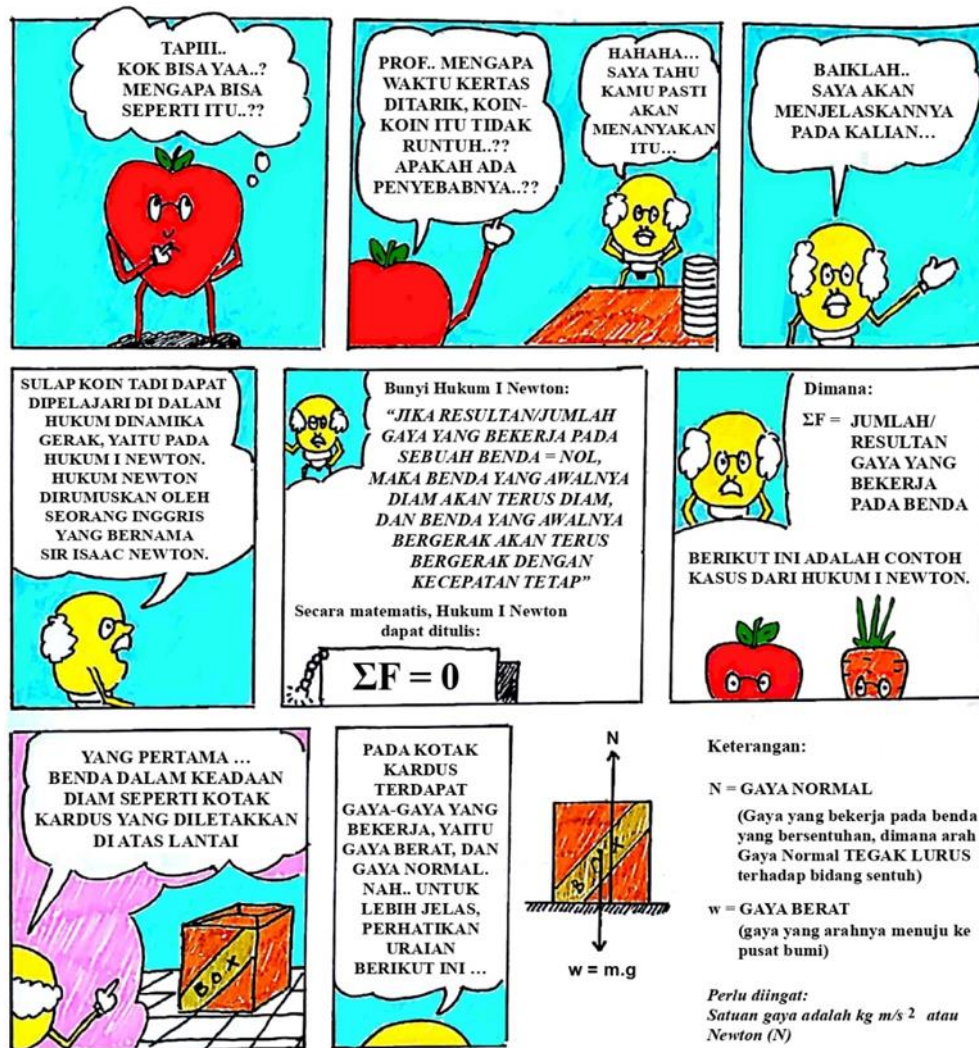


FIGURE 4. Example of Newton's Law design PHYCOM (Physics Comics)

To find out the feasibility of comics that have been designed as teaching materials in schools, a comic validation questionnaire was created. This validation questionnaire contains questions and statements and a validator scoring column. The results of this validation will be used as the basis for the improvement and development of comics.

### Development

Furthermore, the comics that have been designed are validated by three validators consisting of 1 high school physics teacher and two lecturers. The results of this validation become a reference for improving products that have been designed. Product development involves expert judgment, so before field trials are carried out, revisions are first made based on expert assessments and suggestions. The revision made was to improve Physics Comics teaching materials related to material, pictures, illustrations, and sentence content.

### Data Collections and Analysis

The data analysis process in this study includes the analysis of the validation questionnaire of teaching materials by expert validators and students. The validity of the Physics Comics teaching materials was obtained by using a formula:

$$\text{Product validity (\%)} = \frac{\Sigma \text{acquisition score}}{\text{maximum score}} \times 100\% \tag{1}$$

**FIGURE 5.** Formula to determine the percentage of validity of PHYCOM (Physics Comic) products

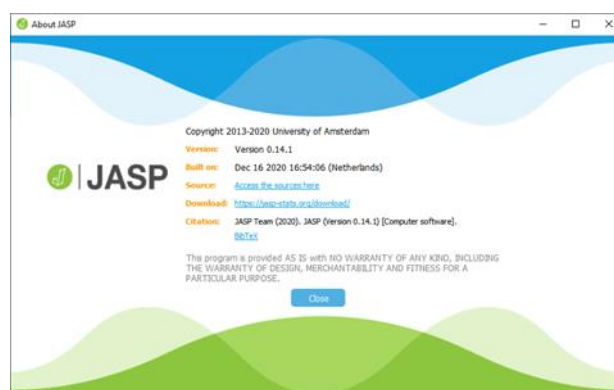
with the criteria for the validity of PHYCOM's teaching materials products is shown in the following table.

**TABLE 1b.** Product validity criteria based on Expert Validation Results (EVR) (Wiyono 2015)

Percentage Range (%)	Criteria
$81.00 \leq VR \leq 100$	Very valid
$61.00 \leq VR < 81.00$	Valid
$41.00 \leq VR < 61.00$	Quite valid
$21.00 \leq VR < 41.00$	Less valid
$VR < 21.00$	Invalid

PHYCOM's teaching materials used were comics with valid and very valid criteria. In this validation test, the scale used in the questionnaire is a *Likert* scale (Sugiyono 2015).

After analyzing the data based on the product validity criteria, statistical analysis was conducted to determine the correlation between each aspect. This statistical analysis is a descriptive analysis conducted with the assistance of Jeffreys's Amazing Statistics Program (JASP). JASP is a free (open-source) statistical analysis software created by the Department of Psychological Methods, University of Amsterdam, The Netherlands. The JASP application used is JASP version 0.14.1.



**FIGURE 6a.** JASP program display

Statistical analysis using JASP is a further analysis of the analysis based on product validity criteria. Validation data that has been obtained and analyzed based on product validity criteria is then entered into the JASP program and then analyzed to determine product validity data based on each aspect, class, average validation, and correlation between each aspect.

## RESULTS AND DISCUSSION

### Initial Observation Results

Initial observations made at SMA Negeri 1 SoE found that physics learning in schools still uses manual textbooks, and there are very few variants of available teaching materials. Students also assume that Physics lessons are very boring because they contain many formulas and are difficult for students to understand. The following are some of the students' opinions regarding learning Physics.

TABLE 2. Student opinions about physics lessons

No.	Student opinion	Student's	Class
1.	<i>"Physics is difficult. The formulas are many, and I don't understand them."</i>	Student A	X MIPA 2
2.	<i>"Physics is no fun subject."</i>	Student B	X MIPA 3
3.	<i>"Calculations in physics are complicated, and I'm lazy to take physics lessons."</i>	Student C	X MIPA 2
4.	<i>"I wasn't really interested in physics."</i>	Student D	X MIPA 2

Based on some of the students' statements above, it can be concluded that students have a negative view of physics lessons. These negative views include: (1) Physics is a difficult subject; (2) Physics lessons are not fun; (3) Student interest in physics lessons is low, and (4) Students are lazy to take physics lessons in class. One of the factors causing these problems is the low self-study ability of students. Achievement of optimal school learning achievement in the student learning process can be obtained by student learning independence (Nasution et al. 2018).

### PHYCOM Teaching Material Design Results

Development of learning media based on Physics Comics to improve students' self-study ability on Newton's Law material. An example of the design results of Physics Comic learning materials can be seen in FIGURE 6b.





FIGURE 6b. The design result of Physics Comics about Newton's Law

**PHYCOM Validation Results by Expert Validators**

The learning media for Physics Comics about Newton's law have gone through the validation stage. The validation process was carried out by three validators: two media experts and one material expert. The average results of the validation of Physics Comics are shown in TABLE 3 with an average percentage of 87.50%. The results of this validation indicate that PHYCOM is suitable for use in learning physics with very valid criteria.

TABLE 3. Physics comics validation results

Product	The percentage of validation results by the validator (%)			Average percentage (%)	Interpretation
	1	2	3		
Comic	81.25	52.00	87.50	87.50	Very valid

Based on the results of the validation of three experts, it was found that there were differences in the validation results of each validator. Validator 1 gave a score of 81.25%, validator 2 gave a score of 52.00%, and validator 3 gave a score of 87.50%.

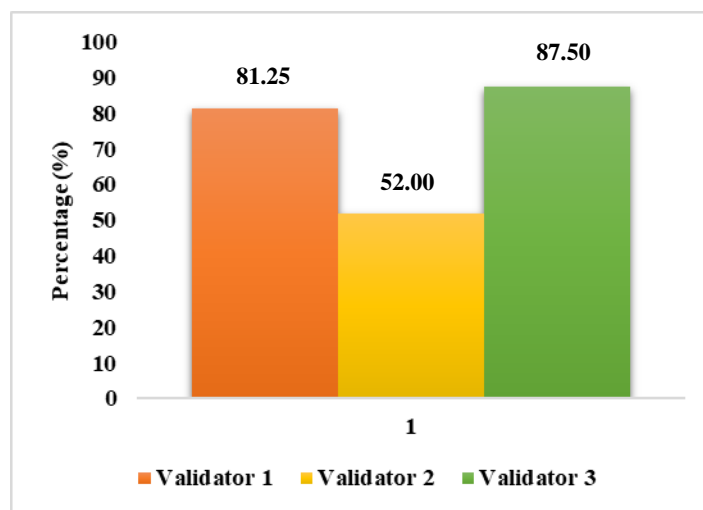


FIGURE 7. The validation result diagram of each validator

The second validator gave a validation score of 52.00% because several aspects did not meet the requirements. Meanwhile, validator one and validator three did not provide comments or suggestions. Therefore, in addition to the validation score, validator two also provides comments and suggestions to improve the design results of physics comics. Comments and suggestions from the validator were then used as a reference for revising PHYCOM 's teaching materials. The revision made was to improve PHYCOM 's teaching materials related to materials, pictures, illustrations, and sentence content.

**TABLE 4.** The results of comic validation by the validator 2

Validator	Aspect which is assessed	Comment	Suggestion
<i>Validator B</i>	Cover	The cover appearance is less attractive	Include the name of the comic writer  Fix the cover. Create a more attractive cover design.
	Contents	The lesson plan (RPP) and the contents of the comics are not in sync	Adjust the contents of the comic with the Learning Implementation Plan (RPP)

Specifically, the percentage for each aspect of physics comics is at a very valid percentage level, namely at the > 80% validity level. The display aspect of writing is included in the very valid category with a percentage of 89.62%. The image display aspect is included in the very valid category with a percentage of 92.20%, the functional aspects of comic teaching materials are included in the very valid category with a percentage of 84.53%. Aspects the benefits of comic teaching materials fall into the very valid category with a percentage of 83.65%.

**TABLE 5.** The results of the validation of Physics Comics in each aspect

Product	Aspect	Percentage of validation for each aspect (%)	Interpretation
Comic	- Writing display	89.62	Very valid
	- Image display	92.20	Very valid
	- Comic material function	84.53	Very valid
	- Benefits of teaching materials	83.65	Very valid

### PHYCOM Validation Results by Students

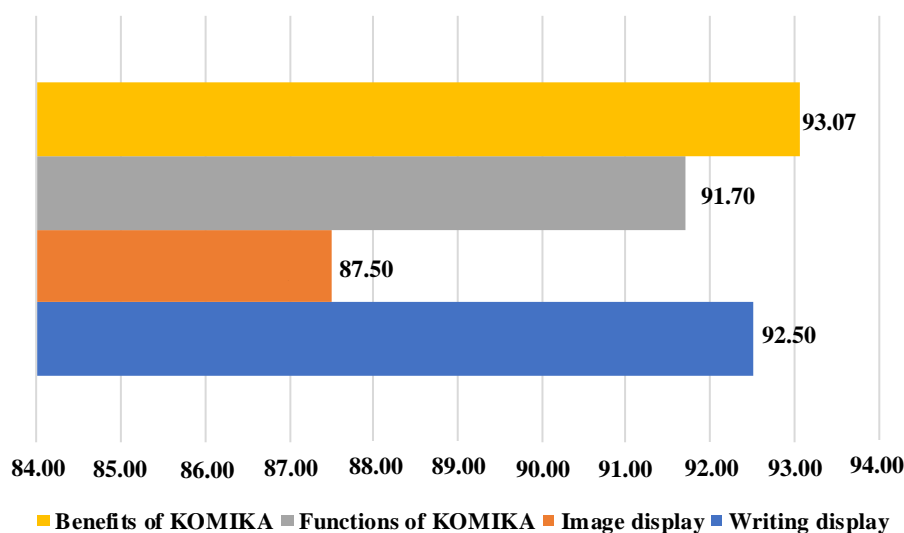
In addition to expert validators, PHYCOM teaching materials are also validated by students as users of teaching materials. This validation aims to determine the feasibility of PHYCOM as a teaching material based on the student's point of view as users. The students who validated PHYCOM consisted of 6 10<sup>th</sup>-grade high school students. The six students consisted of 1 male student and 5 female students. Overall, the average validation results of the six students indicate that PHYCOM's teaching materials are in the very valid category, with a percentage level of 91.18%. The validation results are shown at the intersection point between the mean row and the average validation results column, as shown in TABLE 6.

**TABLE 6.** Descriptive statistics validation results by students

	Student's	Class	Image display	Writing display	Function of PHYCOM	Benefits of PHYCOM	Average validation results (%)	Interpretation
Valid	6	6	6	6	6	6	6	6
Missing	10	10	10	10	10	10	10	10
Mean			92.50	87.50	91.67	93.07	91.18	
Std. Deviation			14.05	17.82	16.68	9.74	14.08	
Minimum			65.00	55.00	58.30	75.00	63.32	
Maximum			100.00	100.00	100.00	100.00	100.00	

Note. Not all values are available for *Nominal Text* variables

From the assessment of six students, different levels of validity were obtained for each aspect of PHYCOM. The aspects in question are the display of writing, the display of images, the function of teaching materials, and the benefits of teaching materials. The level of validity of each of these aspects can be seen in the following figure:



**FIGURE 8.** PHYCOM's level of validity in each aspect

Specifically, the percentage of each student's overall validation results in each aspect is presented in TABLE 7. The differences in student assessments of PHYCOM's teaching materials are different from one another. This can be influenced by many factors such as learning styles, student interests, and intelligence abilities.

However, although the assessments differ between students in each aspect, the overall validation results in each aspect are in the very valid category. The results of this validation show that every aspect of PHYCOM is feasible and has reached the appropriate standard. Therefore, this standard can be used as a reference in making the same teaching materials.

Of the six participants, each gave different validation results from one another. The difference in the results of this validation varies in each aspect, both aspects of appearance, images, display of writing, functions, and benefits. The difference in the results of this validation can be seen in the cumulative percentage as shown in the following data.

**TABLE 7.** Frequencies for Student's

Student's	Frequency	Percent	Valid Percent	Cumulative Percent
Student A	1	6.25	16.67	16.67
Student B	1	6.25	16.67	33.33
Student C	1	6.25	16.67	50.00
Student D	1	6.25	16.67	66.67
Student E	1	6.25	16.67	83.33
Student F	1	6.25	16.67	100.00
Missing	10	62.50		
Total	16	100.00		

Based on the results of the validation of the six participants can be mapped based on the class of participants. The distribution of participants from the three classes was not evenly distributed, where from six participants data were obtained that the most participants came from class X MIPA 4 with 4 participants. While the other 2 participants came from class X MIPA 2 and X MIPA 5. The data for participants by class is shown in TABLE 8.

Based on the distribution of validators by class, it can be seen that the comparison of participants between the three classes is not evenly distributed. The dominance of participants came from class X MIPA 4, while the other two classes only contributed one participant each. However, this result does not affect the validation results of PHYCOM. Participants come from the same class level so that they can be considered ideal and have the same abilities.

**TABLE 8.** Frequencies for Class

Student's	Frequency	Percent	Valid Percent	Cumulative Percent
X MIPA 2	1	6.25	16.67	16.67
X MIPA 4	4	25.00	66.67	83.33
X MIPA 5	1	6.25	16.67	100.00
Missing	10	62.50		
Total	16	100.00		

The results of the validation of the six participants on the aspect of the image display showed different but not significant results. Of the six participants, five gave an assessment in the very valid category with a percentage of 90 and 100, while one other gave an assessment in the valid category. Overall, the image display on PHYCOM is valid and feasible.

The difference in assessment in the aspect of an image display that is quite large can be caused by several factors, namely: 1) students have different intelligence in the field of art; 2) Visual tastes in the types of images, shapes, and colors differ between each student; 3) The influence of other factors such as the ability to see. This is because PHYCOM's teaching materials use the help of a laptop or android so that the size of the image display can be considered in the assessment.

**TABLE 9.** Frequencies for Image display

Image display	Frequency	Percent	Valid Percent	Cumulative Percent
65	1	6.25	16.60	16.67
90	1	6.25	16.67	33.33
100	4	25.00	66.67	100.00
Missing	10	62.50		
Total	16	100.00		

The assessment of the six participants on the writing aspect showed different results. Of the six participants, one person gave different and quite significant validation results. Five participants assessed the very valid category with validation scores of 80, 90, and 100. At the same time, one other participant gave a validation value in the reasonably valid category with a score of 55. Several things like font size, font style, and visibility can influence significant differences in the appearance of this paper.

The difference in assessment in the aspect of writing that is quite large can be caused by the ability to see. This is because PHYCOM's teaching materials use the help of a laptop or android, so the display

size of the writing and the size of the letters are relatively small, making it difficult for students to read properly. This can also be taken into account in the assessment.

**TABLE 10.** Frequencies for Writing display

Writing display	Frequency	Percent	Valid Percent	Cumulative Percent
55	1	6.25	16.67	16.67
80	1	6.25	16.67	33.33
90	1	6.25	16.67	50.00
100	3	18.75	50.00	100.00
Missing	10	62.50		
Total	16	100.00		

The overall validation results show that PHYCOM is feasible to be used as teaching material for students. Of the six participants, there was 1 validation result which was in the valid category while 5 others were in the very valid category. The interpretation of the validation results is shown in TABLE 11.

**TABLE 11:** Frequencies for Interpretation

Interpretation	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6.25	16.67	16.67
Very valid	5	31.25	83.33	100.00
Missing	10	62.50		
Total	16	100.00		

From the table above, one student who gave validation results in the valid category was since the student also gave low validation scores on the aspect of image display and written appearance, so that the accumulation of validation results was also low. Although overall, the validation results are in the valid and very valid categories, the results of this validation become a reference and consideration in improving the PHYCOM design so that it is more suitable for students to be used as teaching materials.

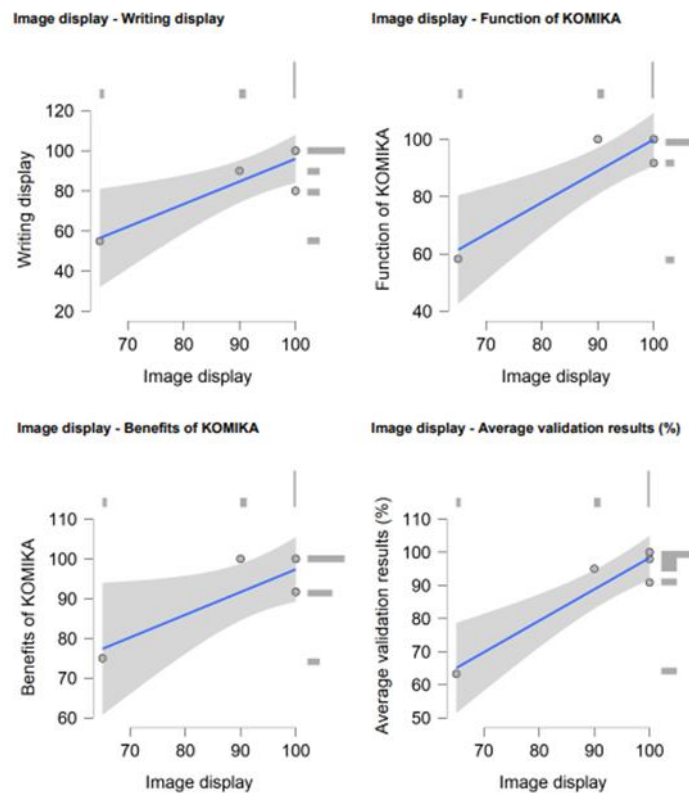
### Correlation between Aspects of PHYCOM Validation Results

Comic validation results in each aspect can be reviewed based on the correlation between each aspect. The following are the results of the correlation analysis between aspects of the PHYCOM validation results.

Based on the results of the correlation analysis between image display and text display; PHYCOM image-function display; PHYCOM benefit-image display; and image display - the average validation results obtained that the correlation between image display aspects and other aspects shows a positive correlation. The positive correlation is shown by the line diagram as shown in FIGURE 9. Overall the correlation results between aspects are in the range of scores of 90-100. A positive correlation indicates that comparable changes follow the high-low score of the validation results in the image display aspect in other aspects.

The results of the plot in the diagram show the distribution of scattered points in the range of 60-100. However, the dominant point distribution is in the 90-100 range. In addition, the long and short lines on the edge diagram indicate the number of students who gave the highest score validation. From the data in the diagram, it can be seen that the participants gave the highest score validation, which means that aspects of PHYCOM are in the very valid category.

The validity of the aspect of the image display includes several things, namely: 1) the shape of the image is appropriate; 2) the image size is appropriate; 3) the suitability of the image with the text is appropriate; 4) the use of images varies, and 5) the color composition used is good.



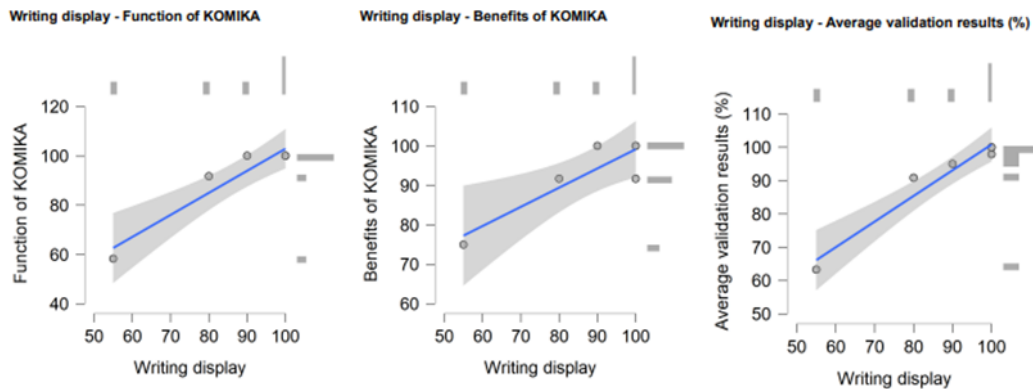
**FIGURE 9.** Correlation between image display aspects and other aspects

The following data analysis is the correlation between PHYCOM's writing function; PHYCOM 's post-benefit display, and the display of the posts - the average of the validation results. The correlation between the written display aspect and other aspects gives a positive result, shown by the line diagram as shown in FIGURE 9. The positive correlation indicates that a comparable score of the validation results in other aspects follows the high-low score of the written display validation result. Overall the correlation between aspects is in the range of 80-100.

The plot results on the diagram show that the relationship between the writing aspect and other dominant aspects in the category is very valid. The data distribution in the form of point plots is significant at the intersection of the lines in the range of 80-100. While the horizontal line on the right side of the diagram as a whole is dominant in the 90-100 range. It can be interpreted that the relationship between writing and other aspects is valid and positively influences each other.

The validity of the aspect of the appearance of the writing includes several things, namely: 1) the writing of the title is correct; 2) The font size is appropriate; 3) The use of words is correct; 4) the writing can be read clearly, and 5) The language used makes it easier to understand the storyline. Research conducted by Agustin et al. (2018) shows that the aspects used in expert validation are accuracy, completeness of presentation, systematic presentation, language suitability with good and correct Indonesian language rules, legibility, and communicativeness. The results of his research indicate that these aspects are stated to be quite valid, with a percentage of 77.7%, and are suitable for use with improvement conditions.



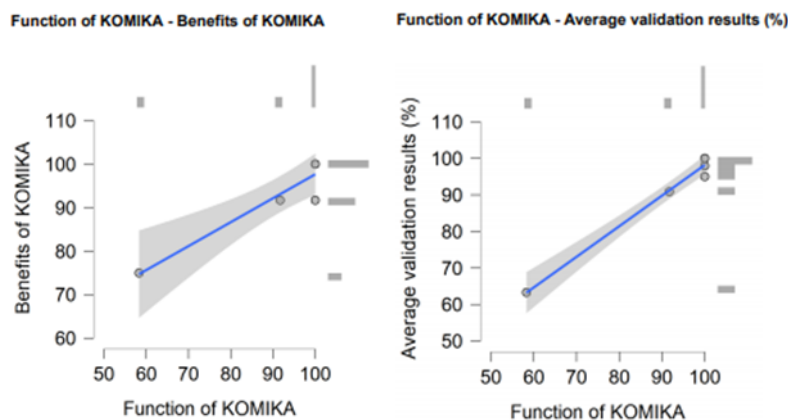


**FIGURE 10.** Correlation between aspect of the appearance of writing with other aspect

The correlation between the PHYCOM function and the benefits of PHYCOM and the average validation results are presented in FIGURE 11. The diagram shows that the correlation between the aspects of the PHYCOM function and other aspects shows a positive correlation.

Based on the plot in the diagram shows, the overall correlation is in the range of scores of 90-100. This shows that the high validation score in the PHYCOM function aspect is proportional to the benefits and average results of PHYCOM validation.

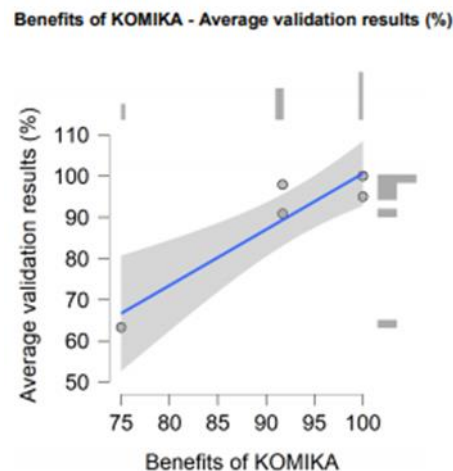
Several things related to the functions and benefits of PHYCOM, namely: 1) comics are suitable as a learning resource; 2) The language used is easy to reach; 3) attract reading interest; 4) leads to understanding the concept; 5) provide entertainment and increase knowledge; and 6) create a sense of pleasure when reading.



**FIGURE 11.** Correlation between the aspect of PHYCOM's function and other aspects.

The following aspect discussed is the correlation between the benefits of PHYCOM and the average aspect of the validation results. The analysis results show that the two aspects show a positive correlation. Overall the correlation between the two aspects is in the range of scores of 90-100. This shows that the high validation score on the benefits of PHYCOM is proportional to the high average validation result. The correlation between the two aspects is shown in FIGURE 12.

The benefits of PHYCOM's teaching materials are: 1) it leads to understanding the concept, 2) it provides entertainment and increases knowledge, and 3) it creates a sense of pleasure when reading. This is supported by the results of research conducted by Gabaron (2017) that teaching materials in the form of comics can develop abilities related to comic literacy, increase interest in reading, and build emotional bonds between students and the object itself. Another study conducted by Lesmono et al. (2012) also found that comics can increase students' learning motivation classically with a percentage of 89.93%. In addition, comics also increase students' understanding of classical concepts by 92.08%. The results showed that students had no difficulty in using physics teaching materials in the form of comics when learning in class.



**FIGURE 12.** The correlation between the benefits of PHYCOM and the average validation results

From the overall validation, results show that PHYCOM (Physics Comics) is very valid and feasible in terms of appearance, function, and benefits to be used as physics material for students. The results of this feasibility test are in line with previous research conducted by Anesia et al. (2018) with the research title Android-Based Comic Media Development on the Subject of Straight Motion, which shows that Android-based comics are classified as good and suitable for use in the physics learning process with a validation percentage of 80.39%. A similar study was conducted by Lestari et al. (2016) for the development of comic-based science teaching materials where the comics feasibility test results were obtained of 4.15 with valid criteria.

## CONCLUSION

Based on the development and due diligence of expert validators, the results show that PHYCOM (Physics Comics) teaching materials on Newton's Law material are very valid and suitable for use as teaching materials for students. Based on the results of the development and due diligence, the authors have several suggestions, namely: (1) Further research is needed to determine the effectiveness of PHYCOM's materials in improving students' self-study abilities; (2) Researchers can then use PHYCOM to examine the influence of PHYCOM in improving students' cognitive, affective, and psychomotor learning outcomes; (3) PHYCOM can be developed into digital comics that can be accessed via mobile devices such as android or laptop; (4) PHYCOM can also be used in further research to determine the relationship between teaching materials and student learning styles and interest.

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